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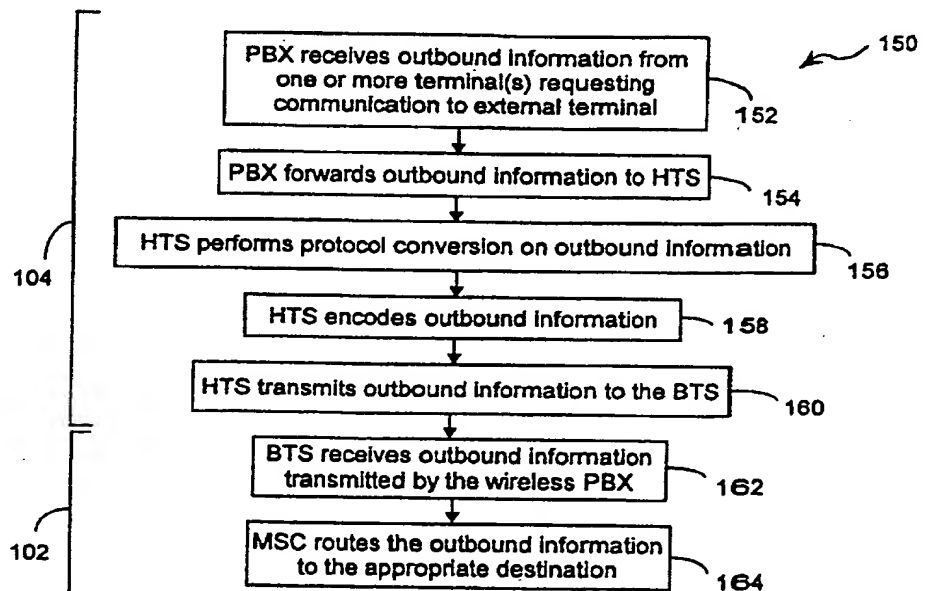
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(54) Title: WIRELESS CO-TENANT BASE STATION

(57) Abstract

A base transceiver station (40) includes a first transceiver configured to communicate with a first mobile station on a first frequency band (SA), and a second transceiver configured to communicate with a second mobile station on a second frequency band (SB). These bands can be, for example, 900 Mhz and 1800 Mhz frequency bands. The base transceiver station (40) includes a processor configured to instruct the first transceiver to receive inbound information from the first mobile station and to transmit outbound information to the first mobile station and to instruct the second transceiver to receive inbound information from the second mobile station and to transmit outbound information to the second mobile station. A trunk module is coupled to the processor and configured to communicate the first information and the second information with a base station controller (20). The base station controller (20) is coupled to the base transceiver station (40) and configured to communicate the inbound information and outbound information with the base transceiver station (40). In one embodiment, a time division multiplexing technique is used to communicate the inbound information and outbound information between the base transceiver station (40) and base station controller (20). Advantages of the invention include the ability to incorporate multiple transceivers communicating over multiple frequency bands in a single base transceiver station (40). This allows easier placement of the various transceivers in a single location and improves cellular service to mobile stations.



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WIRELESS CO-TENANT BASE STATION

REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Ser. No. 09/049,606,
5 pending, which is a continuation of U.S. Ser. No. 08/434,598, now U.S. Pat. No. 5,734,979, incorporated herein by reference; and U.S. Ser. No. 08/927,353, pending, which is a continuation-in-part of U.S. Ser. No. 08/435,709, now U.S. Pat. No. 5,734,699, incorporated herein by reference.

This application claims priority to U.S. Prov. No. 60/071,584 filed on
10 January 15, 1998.

FIELD

The present invention relates to a wireless co-tenant base station. In particular, the base station is capable of providing multiple radios to communicate
15 with different mobile stations on different frequency bands or protocols.

BACKGROUND

Existing cellular base stations are configured to communicate with one type of mobile station. The radios that are incorporated in to the base stations are
20 designed to communicate with one type of mobile station. For example, one type of radio is configured to communicate with a 900 MHz frequency band mobile station and another type of radio is configured to communicate with an 1800 Mhz frequency band mobile station. If a cellular service provider wants to serve both types of mobile stations, the service provider would need to install a 900 Mhz base station
25 and an 1800 Mhz base station.

Therefore, a limitation of existing cellular base stations is that they are not equipped to provide service to multiple types of mobile stations.

What is needed is a cellular base station that can provide service to multiple types of mobile stations.

5

SUMMARY

The invention overcomes the identified problems and provides a base station that can serve multiple types of mobile stations. A base transceiver station (BTS) according to an exemplary embodiment includes a first transceiver configured to
10 communicate with a first mobile station on a first frequency band, and a second transceiver configured to communicate with a second mobile station on a second frequency band. These bands can be, for example, 900 MHz and 1800 MHz frequency bands. The BTS includes a processor configured to instruct the first transceiver to receive inbound information from the first mobile station and to
15 transmit outbound information to the first mobile station and to instruct the second transceiver to receive inbound information from the second mobile station and to transmit outbound information to the second mobile station. A trunk module is coupled to the processor and configured to communicate the first information and the second information with a base station controller (BSC). The BSC is coupled to
20 the BTS and configured to communicate the inbound information and outbound information with the BTS. In one embodiment, a time division multiplexing technique is used to communicate the inbound information and outbound information between the BTS and BSC.

In another embodiment, the first information includes first voice/data
25 information and first control information and the second information includes second voice/data information and second control information. The control information is associated with an Abis communication protocol between the BTS and BSC and is multiplexed over a single Abis link between the BTS and BSC.

Another embodiment of the base transceiver station includes a third
30 transceiver configured to communicate with a third mobile station over a third frequency band. This band can be, for example, a 1900 MHz frequency band. The processor is configured to instruct the third transceiver to receive inbound

information from the third mobile station and to transmit outbound information to the third mobile station. The trunk module is configured to communicate the third information with the BSC. The time division multiplexing technique is used to communicate the third inbound information and third outbound information between
5 the BTS and BSC.

Advantages of the invention include the ability to incorporate multiple transceivers in a BTS for communicating on multiple frequency bands. This allows easier placement of the various transceivers in a single location and improves cellular service to mobile stations.

10

BRIEF DESCRIPTION OF THE FIGURES

Additional advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings, in which:

Figure 1 depicts a cellular network according to the prior art;

15 Figures 2A-B depict a geographically sectorized base transceiver station according to the prior art;

Figure 3 depicts a frequency band sectorized base transceiver station according to an embodiment of the invention;

Figure 4 depicts a base transceiver station and base station controller
20 according to an embodiment of the invention;

Figure 5 depicts the control traffic between a base transceiver station and a base station controller according to embodiments of the invention;

Figure 6 depicts a base transceiver station and base station controller according to an alternate embodiment of the invention; and

25 Figures 7A-B depict a base transceiver station and base station controller according to an alternate embodiment of the invention.

DETAILED DESCRIPTION

Exemplary embodiments are described with reference to specific
30 configurations. Those skilled in the art will appreciate that various changes and modifications can be made to the exemplary embodiments while remaining within the scope of the claims. For example, the exemplary embodiments are described

with reference to the Global Systems for Mobile Communications (GSM) protocol. However, any communication protocol and a wide range of frequencies can be used in the invention.

5 A. The Cellular Network

Figures 1 and 2A-B depict a conventional cellular network 10. A group of base transceiver stations (BTS) 12a-c are positioned in predetermined locations to provide cellular service to a mobile station (MS) 14 over a given area of cells 16a-c. Each BTS 12a-c contain the same protocol and frequency band of transceiver radios
10 to communicate with the same type of MS 14. In a conventional network, for example, the communication between the BTS 12a and MS 14 is in a single frequency band such as a 900 Mhz frequency band. The communication between the BTS 12a and MS 14 includes both voice/data information and control information. The BTS 12a-c are coupled via cables to a base station controller
15 (BSC) 20.

The communication between the BTS 12a-c and BSC 20 includes both voice/data information and control information including a traffic channel, in one embodiment, at 16 or 64 kbit/s carrying speech or data of one radio traffic channel, and a signaling channel at 16 or 64 kbit/s carrying signaling/control information. In
20 GSM the protocol of the signaling/control information is called an Abis link protocol that serves to associate the correct control information with the correct MS 14. This control link is broken down into three logical links for each terminal equipment including a radio signaling link (RSL) used for supporting traffic management procedures, an operations and maintenance link (OML) used for supporting network
25 management procedures, and a layer 2 management link (L2ML) used for transferring layer 2 management messages to a transceiver (TRX) or to the base station control functions (BCF).

The Abis link protocol provides this information to support the radio resource management in the BTS. The basic communications between the BTS and
30 BSC are based on the known cell structures and the transition of MS 14 from one cell to another. Additional complexities of radio resource management are introduced with sectorized cells, where additional radios are positioned in the BTS to

cover specific geographical sectors. In this configuration, the BCF and Abis link must distinguish between radios in the same BTS but having different geographic coverage.

Figures 2A-B depict conventional geographically sectorized cells. This requires additional transceivers in each BTS, but also increases the service capacity. These cells are designed using multiple transceivers and antennas to communicate with specific geographical sectors within a given cell. Figure 2A, for example, is a two-sector BTS and cell where sector 16a1 provides service to MS in angles 1-180 and sector 16a2 provides service to MS in angles 181-360. This configuration requires at least two transceivers, each one servicing one of the sectors. Figure 2B, for example, is a three-sector BTS and cell where sector 16a1 provides service to MS in angles 1-120, sector 16a2 provides service to MS in angles 121-240 and sector 16a3 provides service to MS in angles 241-360. This configuration requires at least three transceivers, each one servicing one of the sectors.

The initialization of the conventional network is also important. The BTS 12a receives instructions from the BSC 20 to instruct the BTS 12a how to set up the base station control functions (BCF). These functions include instructions for each transceiver including what frequency sequence to use, which sector to service and how to service each MS that initiates a call with an off hook signal. Moreover the BCF is responsible for the Abis protocol link that serves to communicate the voice/data and control information between the BTS and BSC.

Figure 3 depicts a frequency band sectorization according to an embodiment of the invention. Instead of the geographical sectors of Figures 2A-B, the invention employs frequency band sectors in a cell 18a. The frequency sectors employ the same geographical space as one another, but operate on different frequency bands. In this embodiment, sector 18a1 represents a 900 Mhz frequency band and sector 18a2 represents an 1800 Mhz frequency band. When a 900 Mhz frequency band MS is in the cell, the MS communicates with the BTS 40 over the 900 Mhz frequency band. When an 1800 Mhz frequency band MS is in the cell, the MS communicates with the BTS 40 over the 1800 Mhz frequency band. The internal structure of the BTS 40 according to an embodiment of the invention is now described.

B. BTS

Figure 4 depicts the internal structure of the BTS 40 according to an embodiment of the invention. A chassis 40 includes a first transceiver (TRXA) 42 configured to communicate on the 900 Mhz frequency band. A second transceiver (TRXB) 44 is configured to communicate on the 1800 Mhz frequency band. These transceivers serve as the basis to communicate over the radio frequency (RF) link with any MS in the cell 18a. In other embodiments, additional transceivers are included within the chassis 40 such as extra 900 Mhz or 1800 Mhz transceivers, and one or more 1900 Mhz transceivers or other transceivers.

Conventional radio frequency communication is used between the BTS and MS. An aspect of the invention is that the MS does not notice any difference between the inventive base station and the conventional base stations depicted in Figure 1. The BTS, however, recognizes each type of MS and communicates with that type of MS in order to service the call. From the perspective of the BTS, outbound information is transmitted to the MS and inbound information is received from the MS. The inbound information includes conventional inbound voice/data information and inbound control information. The control information includes frame numbers and counts. The outbound information includes conventional outbound voice/data information and outbound control information.

A central processing unit (CPU) 46 is coupled to the transceivers 42 and 44 and is configured to process the inbound information and outbound information associated with the MS in the cell 18a. The CPU further provides all the instructions to the transceivers in order to initialize the transceivers. The CPU performs what are called the base station control functions (BCF).

A trunk module 48 is coupled to the transceivers 42, 44 and the CPU 46 and is configured to communicate the inbound information and the outbound information with the BSC 20. The BSC has a trunk module 52 that is configured to communicate inbound information and outbound information with the BTS 40. The BSC has a central processor unit (CPU) 54 that is coupled to the trunk module 52, and to a second trunk module 56 and configured to communicate with the mobile services switching center (MSC) 26, illustrated in Fig. 3. The BSC CPU 54 communicates voice/data information and control information with the BTS CPU 46

over the Abis protocol link between the BSC and BTS. The Abis link provides the radio resource instructions necessary for initialization and ongoing voice/data information and control information transfer.

In conventional cellular systems, the Abis link is capable of carrying the instructions to instruct the BTS to configure itself with the geographical sectors 16a-c illustrated in Figures 2A-B. In the invention, the Abis link is capable of carrying the instructions to instruct the BTS to configure itself with the frequency band sectors 18a-b illustrated in Figure 3. The frequency band sectors, however, are more difficult to initialize because the conventional radio resource management controls are not designed to accommodate this type of arrangement. Therefore, the invention provides an initialization that creates a BCF that can control the transceivers in order to effectively communicate with a plurality of mobile stations on different frequency bands. The initialization procedure provides the configuration parameters that determines the transmission frequency, for example, whether the TRX uses 900 MHz or 1800 MHz frequency bands. In addition to the RF channel, the configuration parameters also specify the power level. In a time domain multiplexed embodiment, the initialization commands further specify which time slots each TRX will use. In GSM, each RF frequency consists of eight TDM time slots. These time slots are also referred to as channels.

Figure 5 depicts various configurations for the BSC/BTS Abis protocol link. In one example, a single TRX BTS 62 includes a single TRX and a BCF to control the TRX. In another example, a three TRX BTS 64 includes three TRXs and a BCF to control the TRXs. In yet another example, a multiple TRX BTS 66 includes a plurality of TRXs each controlled by the BSC 20 over a separate Abis link. In any of these BTS configurations 62, 64, 66, the BSC provides control information to the BCF in the BTS. In the invention, the BCF controls the TRXs for frequency band sectorization. The wireless co-tenant base station of the present invention can be employed with any of these physical configurations.

In an embodiment which uses a single Abis link for more than one TRX, as shown with BTS 64 in Figure 5, time domain multiplexing can be used to couple the TRX signals to the Abis link. Each Abis interface has 30 time slots. In one embodiment, each TRX only uses two time slots. For example, in GSM there are

eight RF time slots. Each RF time slot uses only 16K of the Abis, however, each time slot on the Abis interface has a 64K capacity. Therefore, each TRX only uses a portion of the 64K Abis interface capacity. If additional TRXs are desired to be added, once the 64K Abis interface capacity is exceeded, additional Abis links are
5 established to meet the capacity requirements.

In the BTS 64 embodiment, each TRX includes a FIFO memory. The BCF controls the TRX's by writing commands to the TRX's FIFO memory. The BCF sends the commands to the TRX's over a system bus.

Additional embodiments of a base transceiver station and base station
10 controller are shown in Figures 6 and 7A-B. Figure 6 shows that additional trunks can be employed between the BTS and the BSC in order to handle each of the TRXs respectively. Figures 7A-B show that the communication between the BTS and BSC can be performed using a time division multiple access (TDMA) technique where each TRX is allocated a time slot and the BCF places respective control/data
15 information in each respective time slot and transfers the TDMA word to the BSC.

C. Conclusion

Advantages of the invention include the ability to incorporate multiple transceivers communicating over multiple frequency bands in a single BTS. This
20 allows easier placement of the various transceivers in a single location and improves cellular service to mobile stations.

Having disclosed exemplary embodiments and the best mode, modifications and variations may be made to the disclosed embodiments while remaining within the scope of the invention as defined by the following claims.

CLAIMS

What is claimed is:

1. A base transceiver station (BTS) for communicating with a first mobile station on a first frequency band and a second mobile station on a second frequency
5 band, comprising:
 - a first transceiver configured to communicate, in a geographic cell, first information with said first mobile station over said first frequency band;
 - a second transceiver configured to communicate, in the geographic cell, second information with said second mobile station over said second frequency
10 band;
 - a processor coupled to said first transceiver and said second transceiver and configured to perform base station control functions including to instruct said first transceiver to communicate with said first mobile station and to instruct said second transceiver to communicate with said second mobile station; and
15 a trunk module coupled to said processor and configured to communicate said first information and said second information with a base station controller (BSC).
2. The BTS of claim 1, wherein:
20 said first information includes first voice/data information and first control information;
said second information includes second voice/data information and second control information;
said processor is configured to multiplex said first information and said
25 second information via said trunk module with said BSC.
3. The BTS of claim 2, wherein:
said first control information includes first Abis information;
said second control information includes second Abis information; and
30 said processor is configured to multiplex said first Abis information and said second Abis information via said trunk module with said BSC.

4. The BTS of claim 1 for further communicating with a third mobile station on a third frequency band and further comprising:
a third transceiver configured to communicate with said third mobile station over said third frequency band; and
- 5 said processor is coupled to said third transceiver and configured to instruct said third transceiver to communicate with said third mobile station.
5. The BTS of claim 4, wherein:
said first information includes first voice/data information and first control
10 information;
said second information includes second voice/data information and second control information;
said third information includes third voice/data information and third control information; and
- 15 said processor is configured to multiplex said first information, said second information and said third information via said trunk module with said BSC
6. The BTS of claim 5, wherein:
said first control information includes first Abis information;
20 said second control information includes second Abis information;
said third control information includes third Abis information; and
said processor is configured to multiplex said first Abis information, said second Abis information and said third Abis information via said trunk module with said BSC.
- 25
7. A base station controller (BSC) for communicating with a base transceiver station (BTS) having a plurality of communication frequency bands, comprising:
a trunk module configured to communicate, in a geographic cell, first
information associated with a first frequency band of said plurality of frequency
30 bands and to communicate, in the geographic cell, second information associated with a second frequency band of said plurality of frequency bands.

8. The BSC of claim 7, further comprising:

a processor configured to associate said first information with a first mobile station in a first frequency band and said second information with a second mobile station in a second frequency band.

5

9. A trunk module for use with a multi-band cellular communication network, comprising:

an Abis link configured to multiplex first control information representing communication over a first frequency band and second control information

10 representing communication over a second frequency band.

10. A method of communicating with a first mobile station on a first frequency band and a second mobile station on a second frequency band, comprising the steps of:

15 communicating, in a geographic cell, first information with said first mobile station over said first frequency band;

communicating, in the geographic cell, second information with said second mobile station over said second frequency band;

20 performing base station control functions including instructing a first transceiver to communicate with said first mobile station and instructing a second transceiver to communicate with said second mobile station; and

communicating said first information and said second information with a base station controller (BSC).

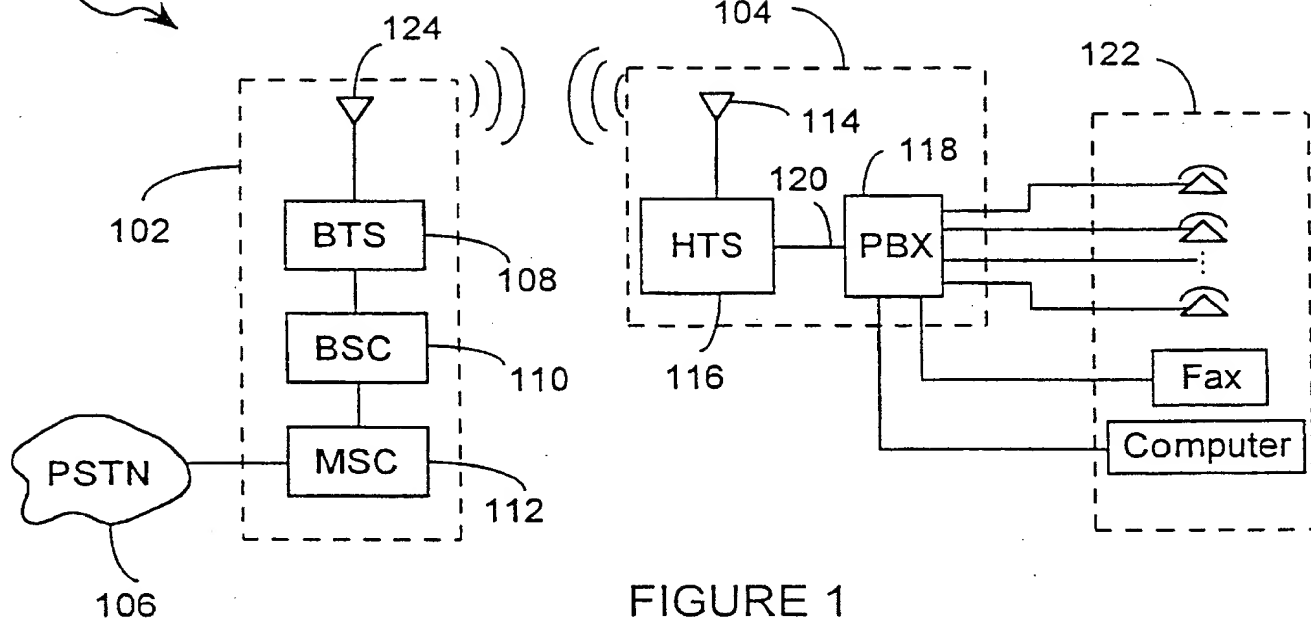


FIGURE 1

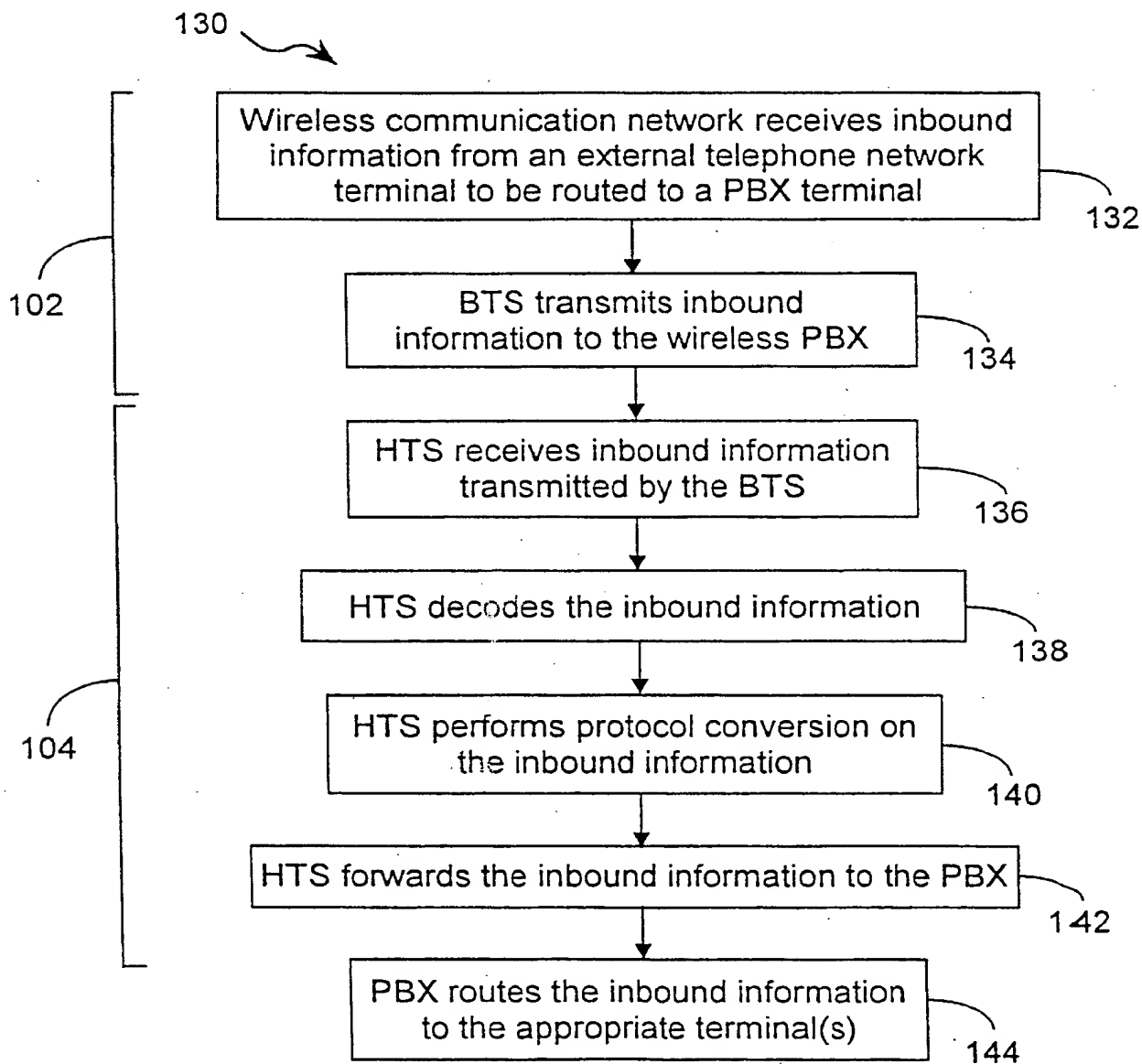


FIGURE 2

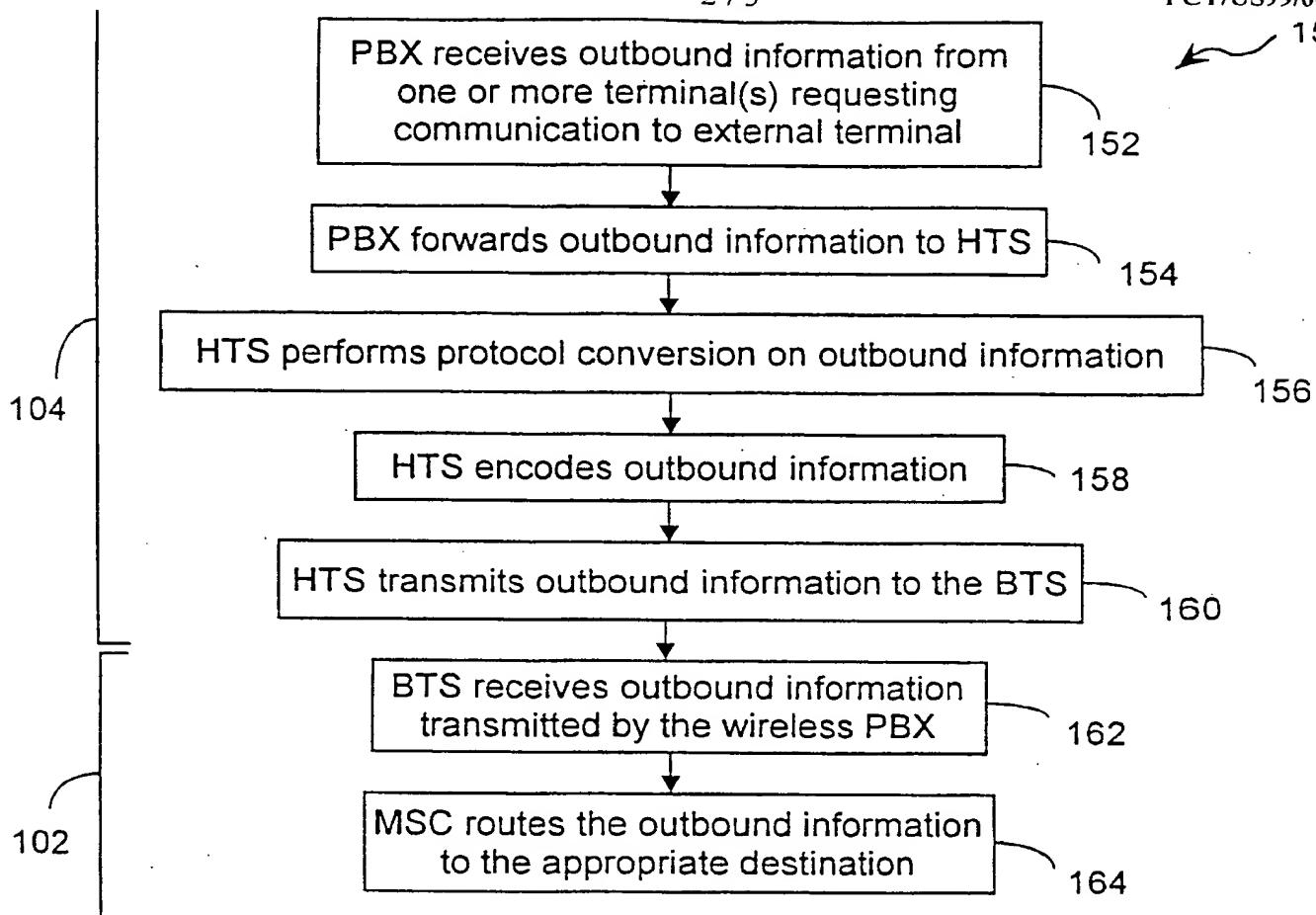


FIGURE 3

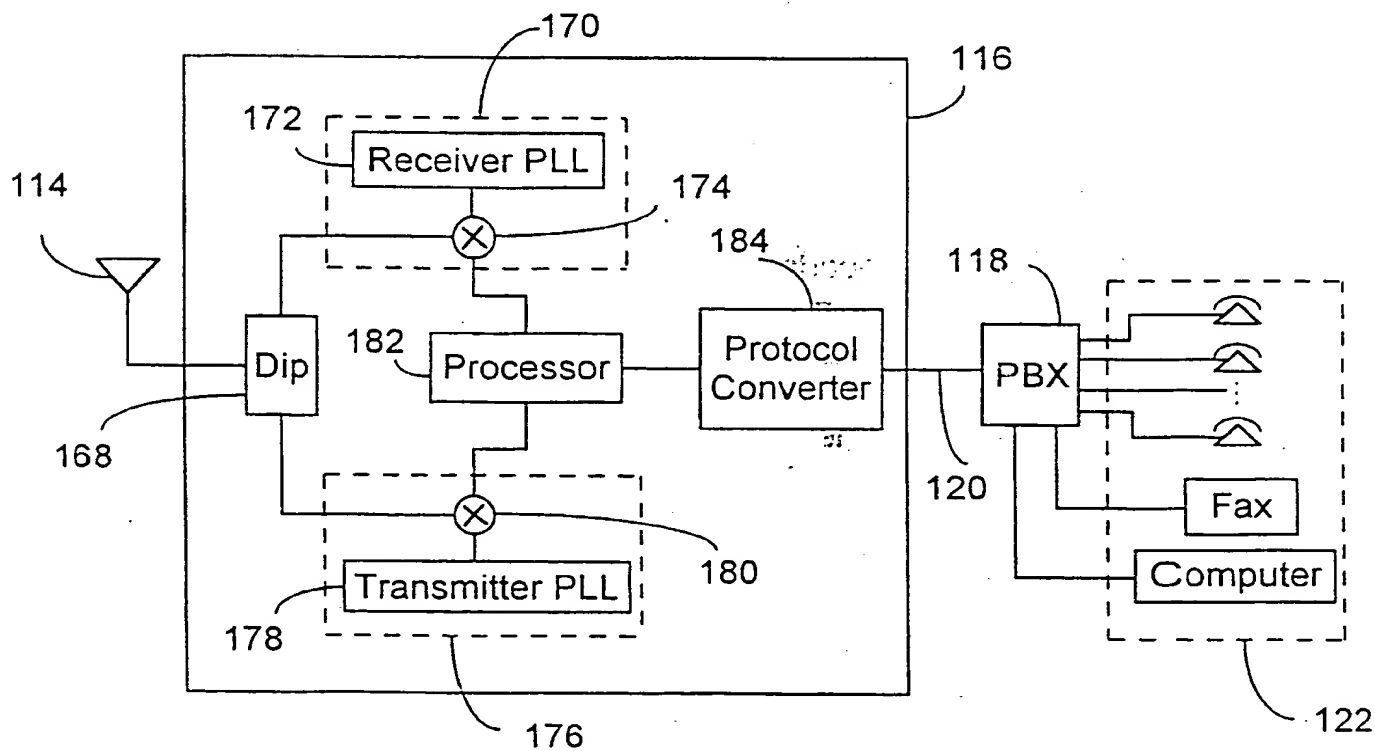


FIGURE 4

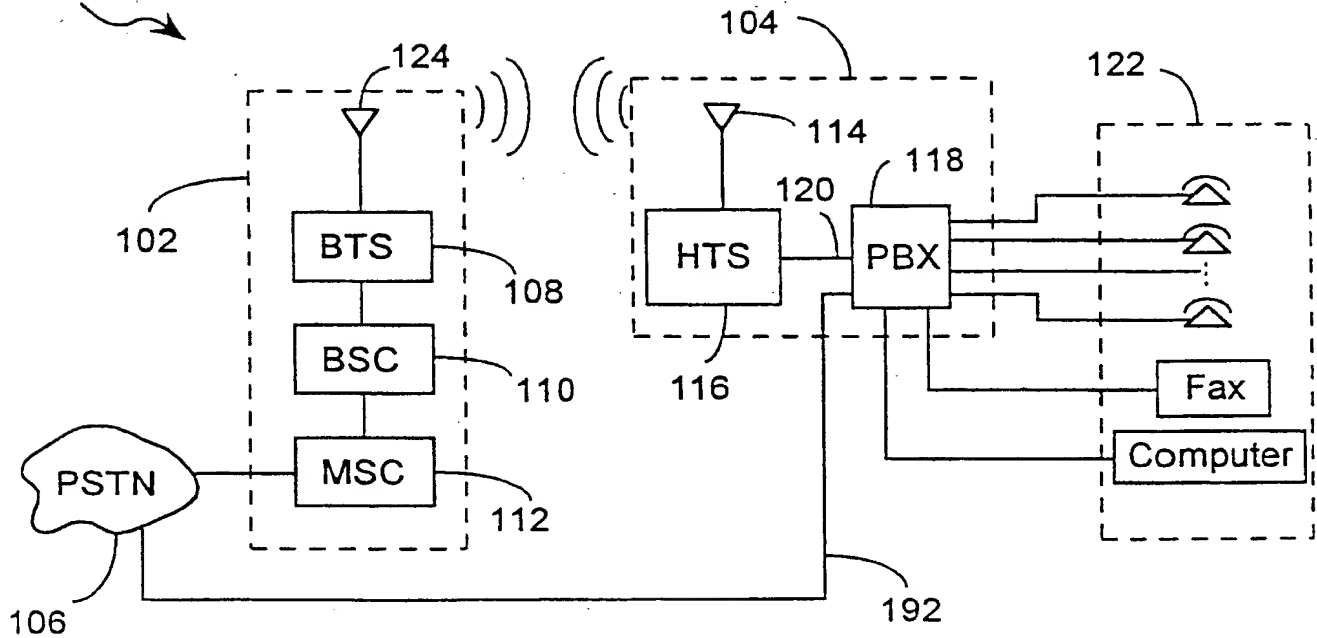


FIGURE 5

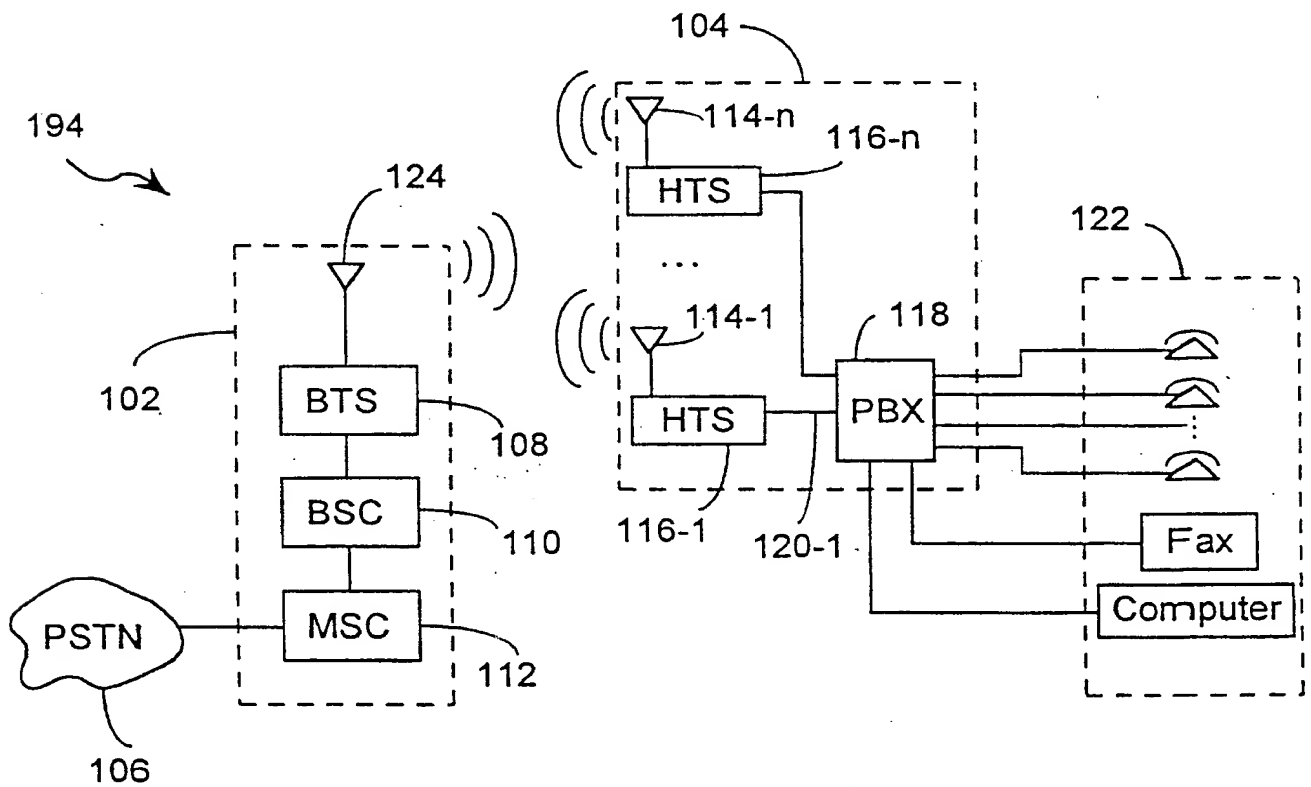


FIGURE 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/00844

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04B 1/38; H04M 1/00

US CL :455/426, 552, 560, 561

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/426, 552, 560, 561, 422, 454, 553

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONEElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,457,734 A (ERYAMAN ET AL) 10 October 1995, column 1 line 13 to column 2 line 46, column 3 line 7 to column 5 line 62.	1-10
A, P	US 5,822,693 A (HARRISON) 13 October 1998, columns 2-6.	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

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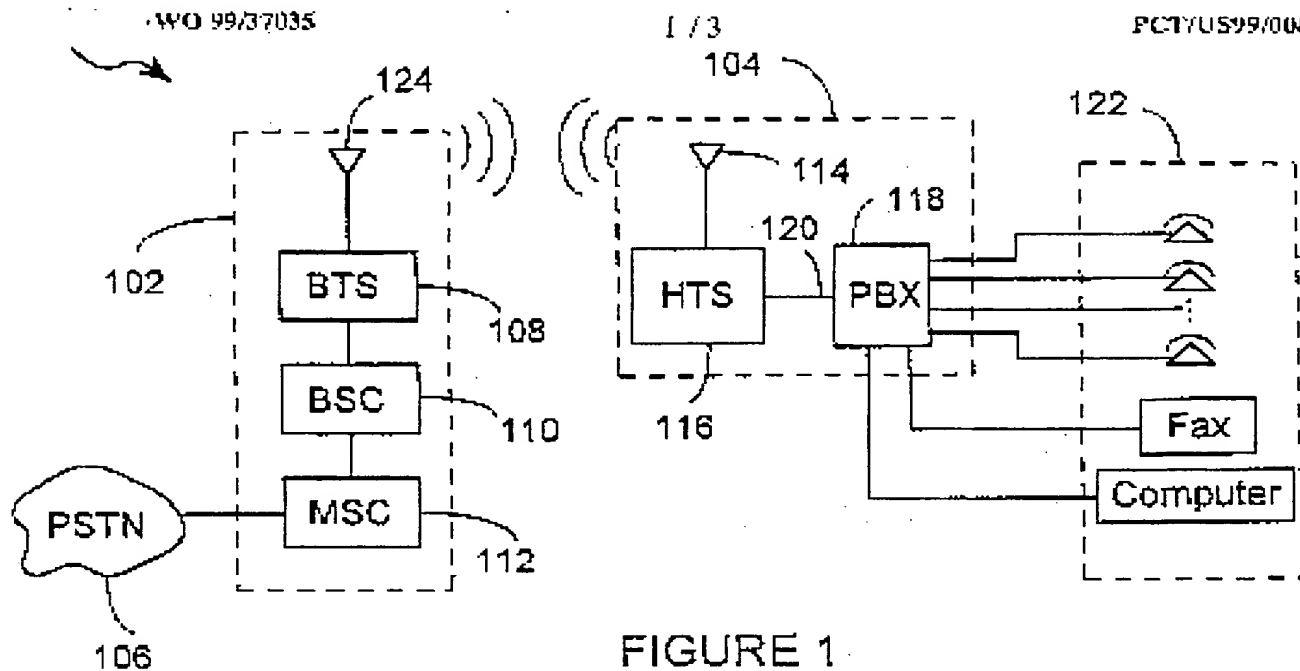


FIGURE 1

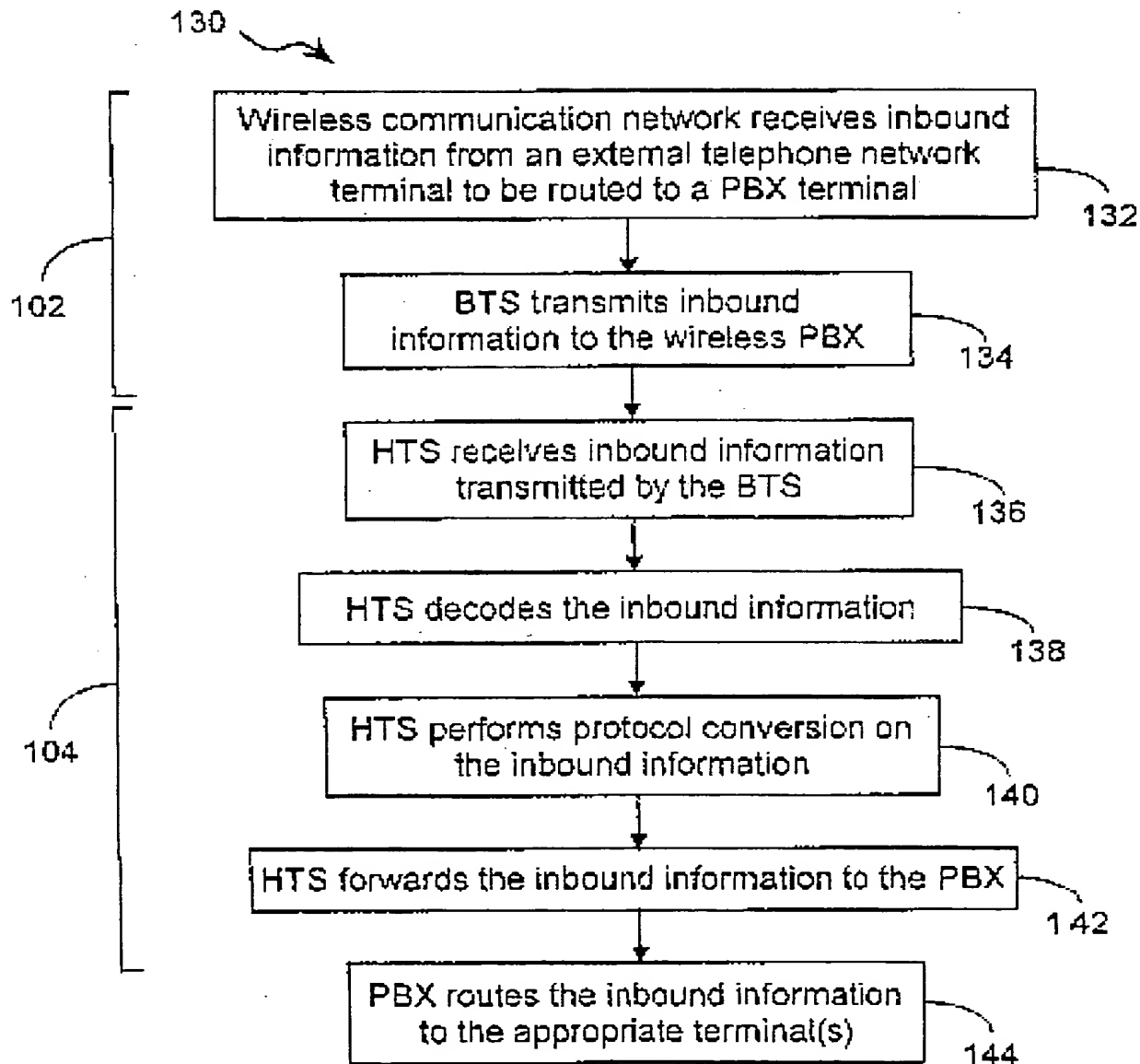
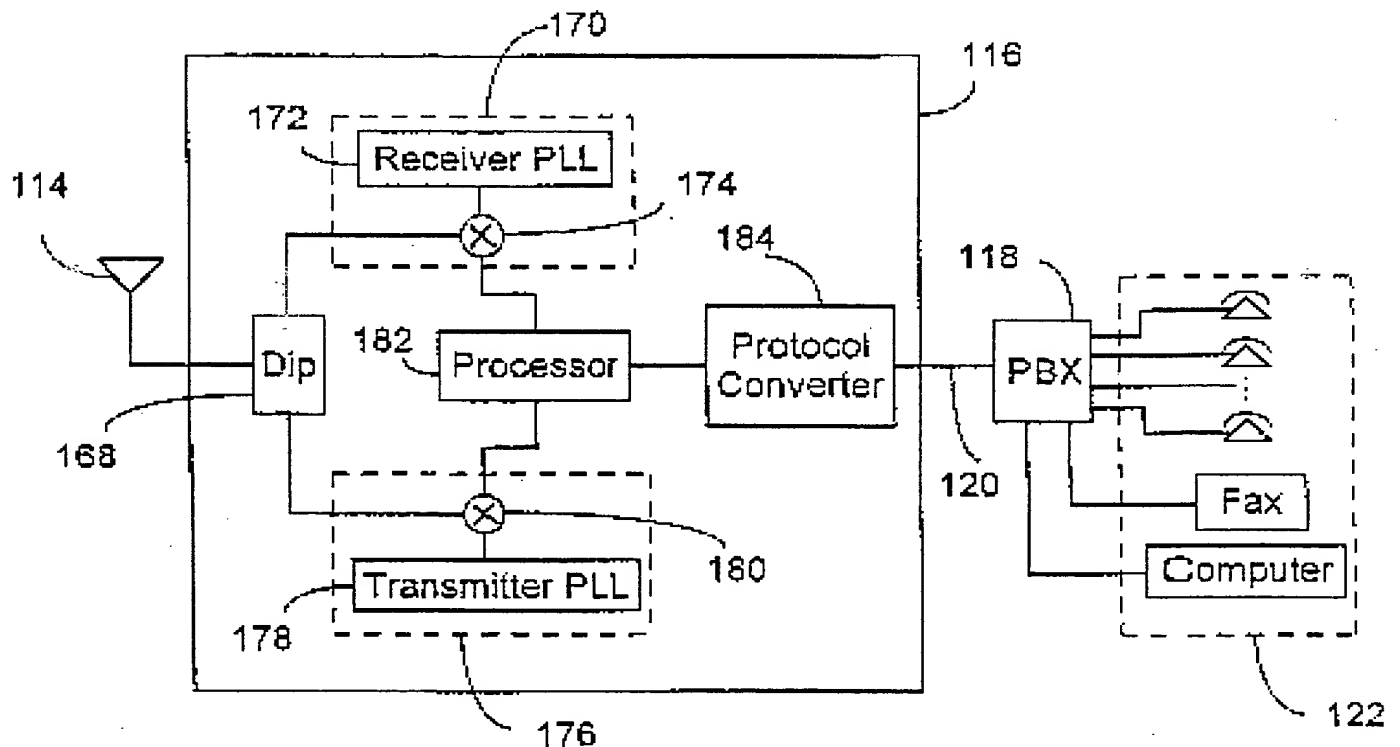
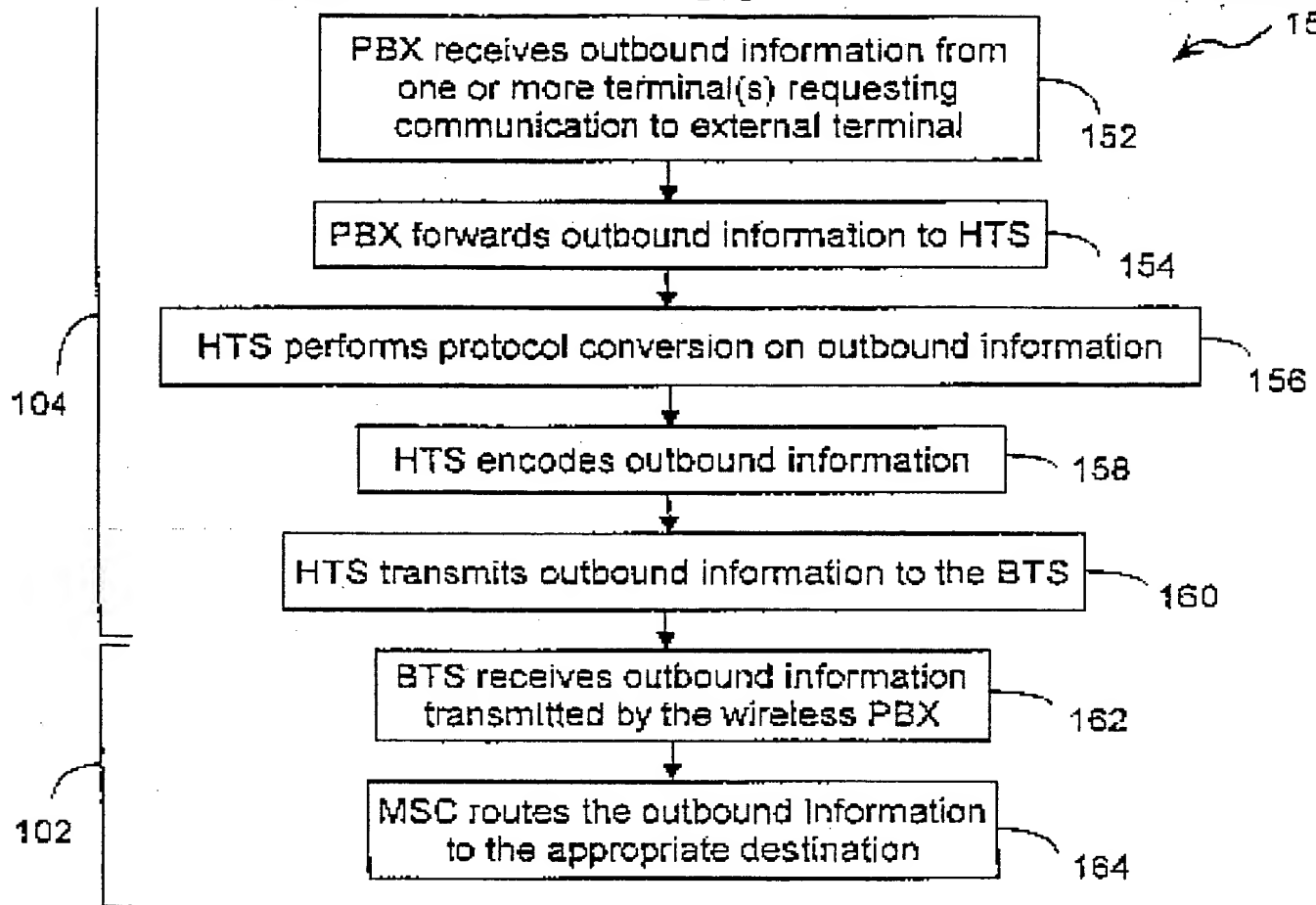


FIGURE 2



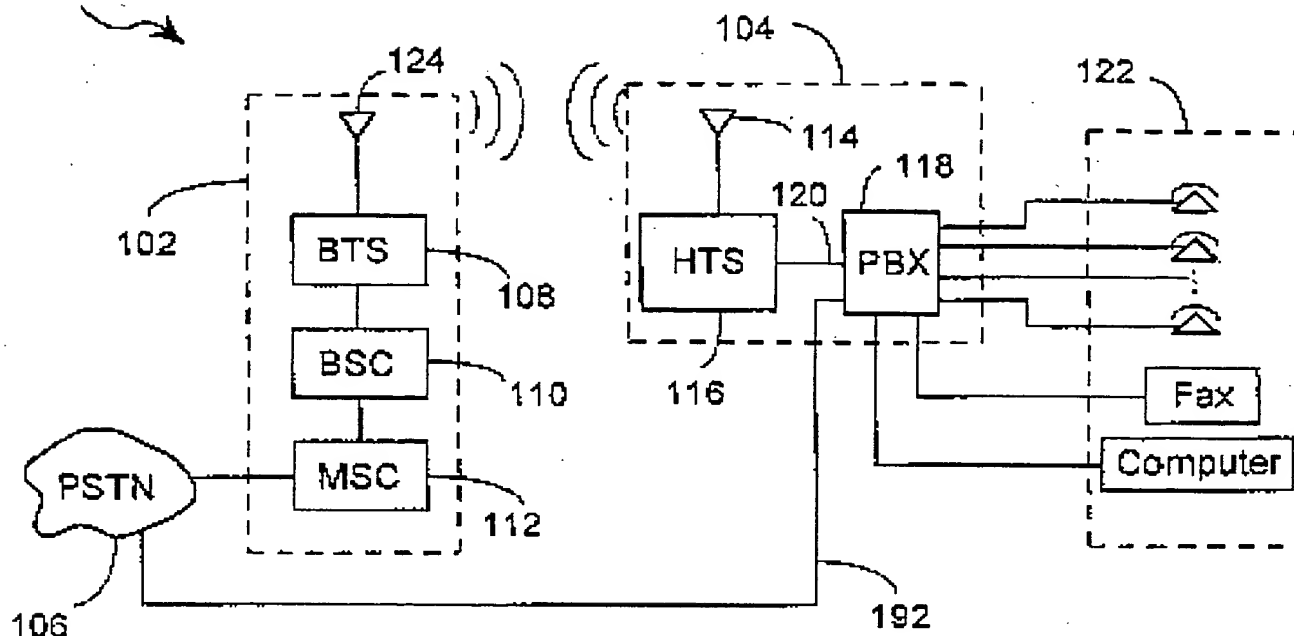


FIGURE 5

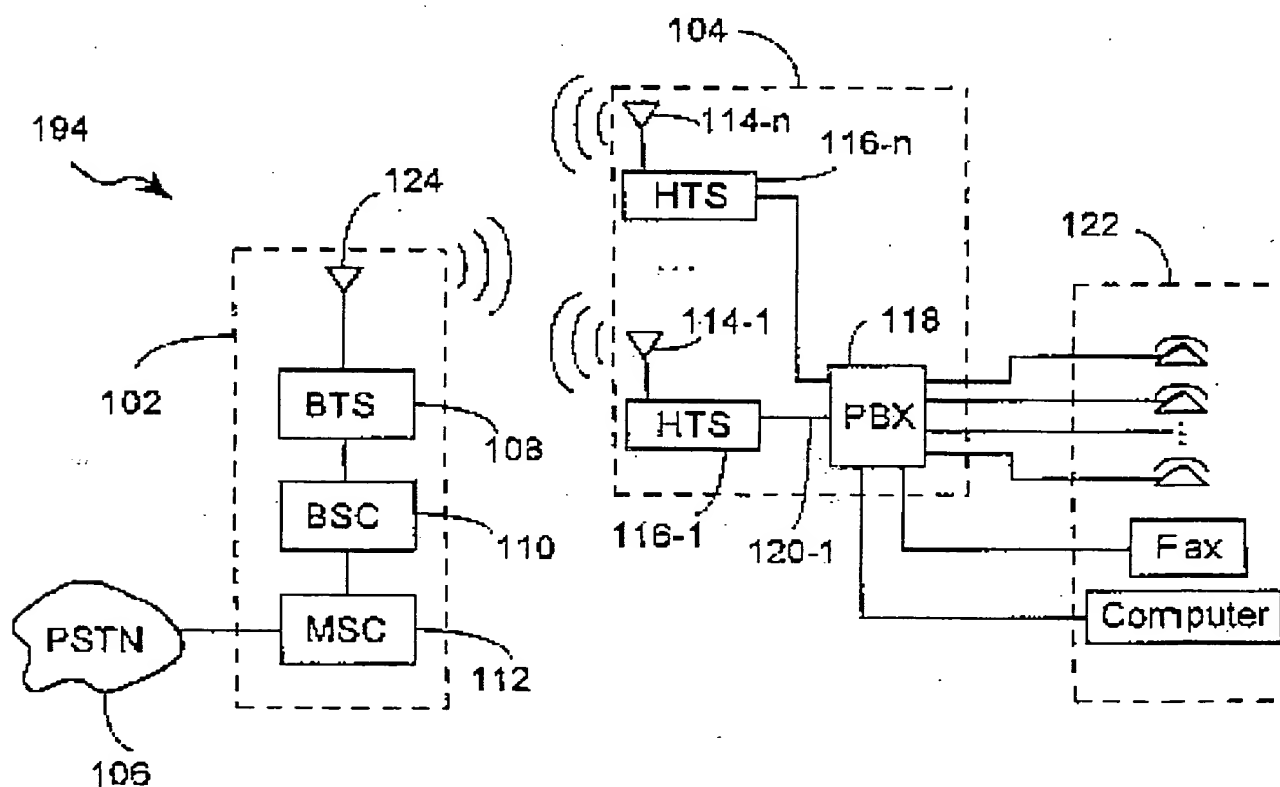


FIGURE 6

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